

OAK RIDGE Y-12 PLANT INFORMATION CONTROL FORM

3226
ChemRisk

DOCUMENT DESCRIPTION (Completed by Requesting Division)

Document No: Y-KB-64 Date of Request: OCT 14, 1996 Requested Date of Release (Allow 5 to 10 Days): OCT 24, 1996 Page Count: 76

Unclassified Title: DIAGNOSTIC AIR MONITORING AND RELATED SAMPLING EQUIPMENT FOR RADIOACTIVE AND TOXIC PARTICULATES (BOX # 22-6-6)

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INTENDED AUDIENCE: ☐ Public ☐ Environmental Regulators ☐ NWC ☐ DOE Contractors ☒ Other ChemRisk

TYPE: ☐ Abstract ☐ Brochure ☐ Co-op Report ☐ Formal Report ☐ Informal Report
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☐ Thesis/Term Paper ☐ Videotape ☐ Other _____
☐ Oral Presentation (Identify meeting, sponsor, location, date). _____

PATENT OR INVENTION SIGNIFICANCE ☐ Yes ☐ No (Identify) _____ Document will be published in proceedings ☐ Yes ☐ No
 Document has been previously released ☐ Yes ☐ No (Reference) _____ Document will be distributed at meeting ☐ Yes ☐ No

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Date Issued: January 5, 1966

Document Y-KB-64

UNION CARBIDE CORPORATION
Nuclear Division

Y-12 PLANT

Contract W-7405-eng-26
With the US Atomic Energy Commission

(B)

DIAGNOSTIC AIR MONITORING AND RELATED SAMPLING EQUIPMENT
FOR RADIOACTIVE AND TOXIC PARTICULATES

Merwyn Sanders

A paper presented at the Fall Symposium of the
Baltimore-Washington Chapter Health Physics
Society on September 18, 1965.

Oak Ridge, Tennessee
September 15, 1965

DIAGNOSTIC AIR MONITORING AND RELATED SAMPLING EQUIPMENT FOR RADIOACTIVE AND TOXIC PARTICULATES

INTRODUCTION

Today's presentation will consist of three major parts: (1) the General Air-Monitoring Program employed at the Y-12 Plant; (2) the Diagnostic Air-Monitoring Program which some call Breathing-Zone, Operational-Type Air Sampling; and (3), if time permits, I would like to show you some slides of the Y-12 Plant's air-sampling equipment which may be of interest to you.

GENERAL AIR MONITORING PROGRAM

The general air monitoring program in the Y-12 Plant is considered unique. Y-12 is possibly the only plant in the world that uses an IBM aperture card equipped with a filter medium to collect air samples.

Advantages

I would like to emphasize several of the advantages of this system: (1) air samples and air-sample records are combined into one unit; (2) the possibility of laboratory error in recording and correlating sample results with sample locations is eliminated; (3) a means of automation of analysis is provided for most of the air-monitoring programs which use a filter paper for a collection medium; (4) air-sampling and laboratory analysis costs are reduced; (5) a means of centralized air-sample analysis is provided which permits practical air monitoring in areas where laboratory services are not available (that is, we can program input data cards that could be returned

to our laboratories for processing at a very reasonable cost); (6) commercially available card-handling equipment which has already been perfected and developed is utilized; (7) practical and universal standardized sampling collection procedures can be established; (8) a large number of samples can be processed automatically, and (9) convenient storage of sample results for future reference in the case of historical records, legal records, and statistical comparisons with other related programs is achieved.

Equipment and Operation

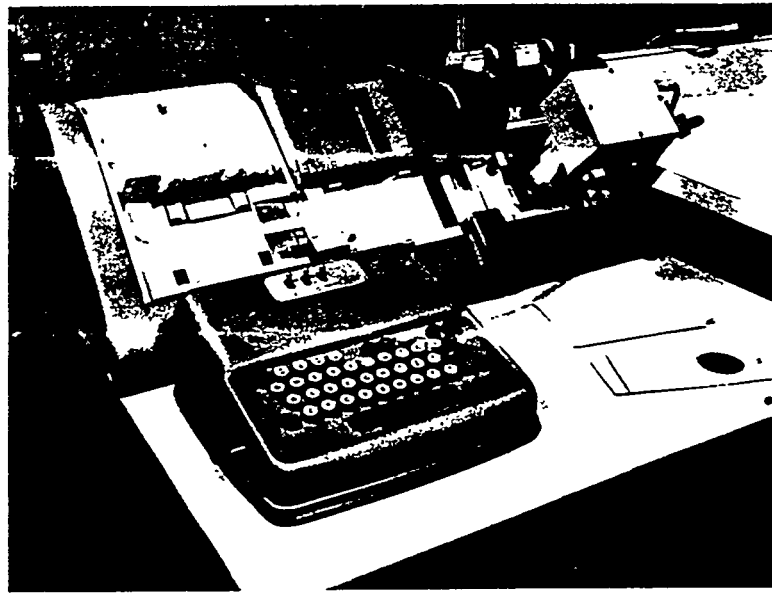
IBM aperture cards for the general air monitoring system are procured commercially with a Whatman 41 filter-paper disc mounted and ready for use. These cards are prepunched as to sampling location, date, air volume, and the time that the sample is to be taken. The sample location and date are printed at the top of the card so that the operator, as shown in Slide 1, can change these cards in the air-sampler holders with a minimum of effort. The sample-card holder is constructed from molded polypropylene. The cost of this sampling head, recently developed at Y-12, is approximately forty-eight cents compared to conventional sampling heads which are commercially available at nine or ten dollars. After the cards have been collected in the field, they are transported to our plant laboratory for automatic counting. The counting system which we use (Slide 2) consists, simply, of a modified IBM machine—a standard 0 - 26 IBM key punch which has been equipped with a scintillation counter containing a zinc sulfide crystal. The aperture cards are replaced in the scintillator for counting. To maintain effective analytical control, standards and blanks are placed in the counter with the actual sampling cards.



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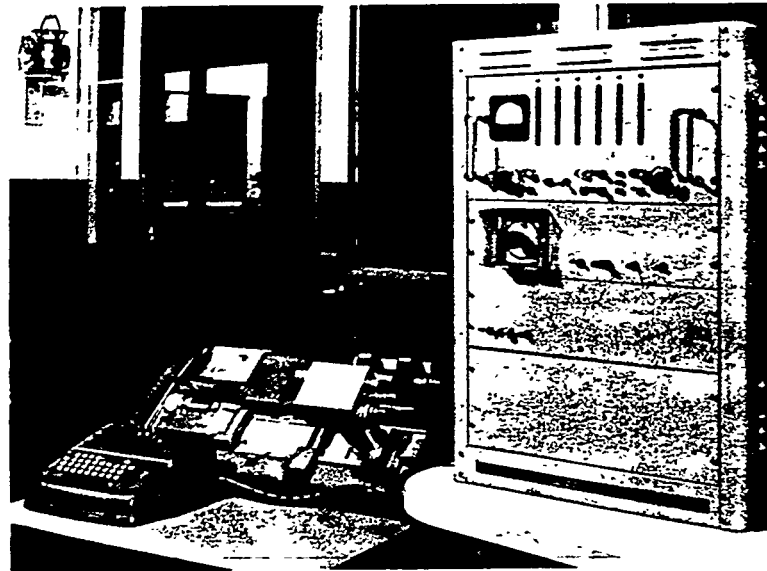
Slide 1. OPERATOR CHANGING AN APERTURE SAMPLE CARD FROM THE SPECIAL CARD HOLDER.

In Slide 3 we see the electronics which are associated with this card-transport mechanism. The counts that are detected by the scintillation counter are registered and recorded by a Berkeley scaler. The rate meter clears itself, but the counts that were "seen" previously are placed in the memory system. Then the results are punched automatically into the proper card. This memory system has several unique features one of which is its ability to recognize known standards that are going through the counting process. If these standards do not at any time count within



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Slide 2. IBM 0-26 KEY PUNCH MACHINE EQUIPPED WITH A SCINTILLATION DETECTOR.



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Slide 3. COUNTER ELECTRONICS ASSOCIATED WITH THE 0-26 KEY PUNCH MACHINE.

certain established limits, the counter will automatically shut off, flash a light, and sound a bell to indicate that something is wrong. Also, the memory system has the ability to recognize blank cards which are placed within a deck of cards during a

normal run of samples. If the background at any time changes significantly from one sample to another, here again the instrument will cut off, flash a light, and ring a bell. There is another feature of this instrument. As you well know, general air-type monitoring generates a considerable amount of negative data; however, we are mainly interested in looking and seeing indications of possible higher concentrations or anticipating the problem locations. Thus, cards that have little activity on them are only counted for one minute. But, if a card comes through with significant levels (above a given established limit), the card is counted for six minutes for better counting statistics. Upon completion of the counting process, an IBM 1401 computer is used to tabulate, calculate, and print out the area locations where the samples were obtained. With this equipment, between three and four hundred samples can be processed automatically in approximately five minutes. This automated processing of the aperture cards provides a print out of data which can be used by area supervision and monitoring groups to evaluate the effectiveness of the control in areas from a general air-monitoring standpoint.

Potential Applications

The application of this principle of using and combining IBM cards with a filter medium, or with many types of samples, is virtually unlimited. It is easy for me to imagine that this is a logical technique to be used for optical-density measurements where repetitive-type measurements are taken, namely: colorimetric analysis, spectrographic analysis, and X-ray analysis. Certain medical programs in hospitals (for example, blood tests) could be placed on a sensing filter of some type. The use of this sensing filter would permit an automatic read out and tabulation of

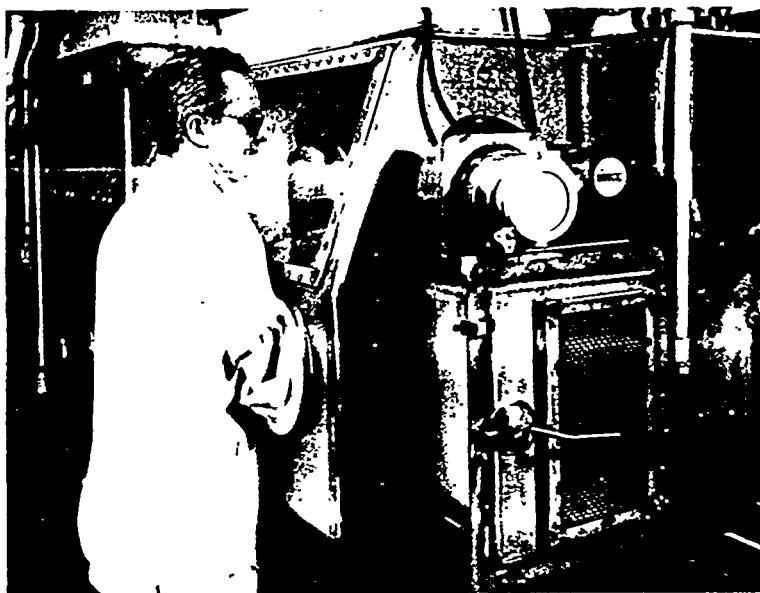
data. Also, the results obtained could be recorded on the same type of card. Thus, the card, sample, and data would be prevented from becoming separated from the original source, thereby providing a high integrity for the analysis. I may add, as a result of Y-12 using this particular principle, the Biology Division of the ORNL is now placing their tissue slides on IBM aperture cards. A Mylar film is mounted in the aperture, then the actual tissues are floated upon the Mylar film and are fixed. This method provides a means of cataloging and storing slides and keeps the data and records from becoming separated from their respective slide. The process of using Mylar film for microscopic slides was perfected at Duke University; but, to my knowledge, the ORNL Biology Division is the only group that is using the process in conjunction with the aperture cards. The elimination of conventional glass slides by this method constitutes a saving of thousands of dollars a year.

DIAGNOSTIC AIR MONITORING

The second portion of my presentation will be devoted to diagnostic air monitoring as employed in the Y-12 Plant. It is our philosophy that if you can control a contaminant at the source, you really have no air-monitoring problems. The equipment I would like to show in the next series of slides is the equipment that we use in our diagnostic air-monitoring program.

Equipment

Slide 4 shows a typical setup for monitoring air concentrations generated while moving material in and out of a dry box. The sampling unit shown is a standard

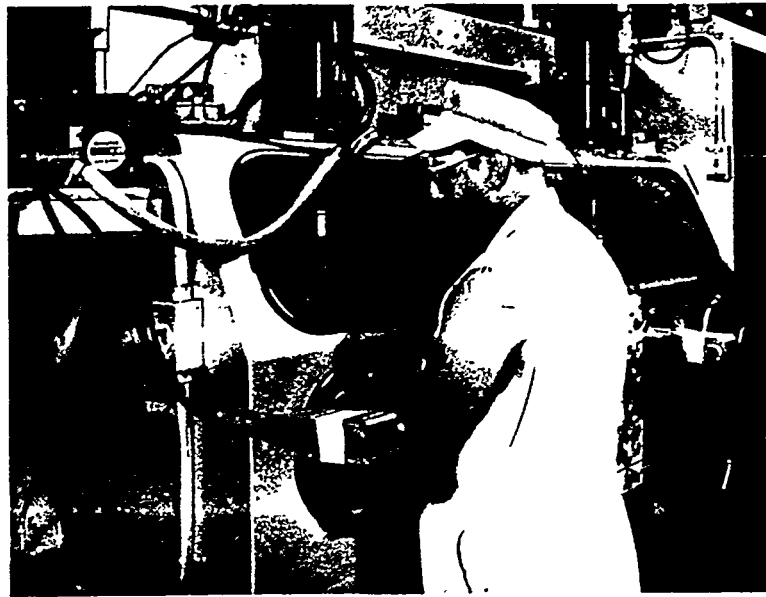


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Slide 4. HIGH-VOLUME AIR SAMPLER WITH A TIMER ACTIVATED BY A MICRO SWITCH.

high-volume, air-sampling unit equipped with a timer which operates in conjunction with the sampler. The sampler is activated by a micro switch which may be seen in the upper left-hand corner of the dry-box door. The sample is only operational when the door is in the "open" position. This type of sampling can reveal: (1) the effectiveness of the equipment for containment, and (2) something about the operator's efficiency and his technique.

Slide 5 indicates how photoelectric cells can be used as the sampler's activating device. When the employee is at the box in the normal operating position, he breaks the light beam which, in turn, opens a solenoid valve equipped with a critical orifice. The valve is connected to the house vacuum system and activates the sampler located approximately at the breathing zone of the operator. The timer records the total sampling time. This little device, including the photoelectric cells, costs



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Slide 5. TWO-INCH AIR SAMPLER POWERED BY THE HOUSE VACUUM WITH THE SOLONOID VALVE AND TIMER ACTIVATED BY PHOTO-ELECTRIC CELLS.

less than fifty dollars to assembly. I may add that the photoelectric cell and timers are commercial items.

A gray box can be seen on the left-hand side of Slide 6. We call the box a master-control air-sampling center. This equipment can be used in conjunction with the house vacuum system, with a high-volume sampler (as shown here), or with any other type of pumps or air-moving devices. On the front of this box is a series of receptacles which can accept a variety of activating devices. In this particular operation an electronic carpet is in use. When the operator is standing on the carpet, the sampler operates. When the operator leaves that particular location, the sampler stops. The length of time spent working at this operation is recorded by the timer in the system. Additional timing units and samplers at different locations in an operating area can be controlled by this unit. For example, this particular



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Slide 6. MASTER AIR-SAMPLING CONTROL CENTER ACTIVATED BY AN ELECTRONIC CARPET.

operator has a series of given tasks to do at different locations. By utilizing this device we can sample the concentrations associated with each given operation. These units cost approximately one hundred dollars to fabricate and build. Notice the clip board which is located at the right of the operator. We ask the operators to record their names, the type of operation, and the type of material that they are handling. Therefore, when the sample results are obtained, we have a complete story concerning what operation took place, the individual's name, and the sam-

pling date. These instruments permit sampling during off shifts without the presence of Health Physics or Industrial Hygiene personnel. This type of monitoring has been the backbone of our diagnostic program.

AIR MONITORING EQUIPMENT

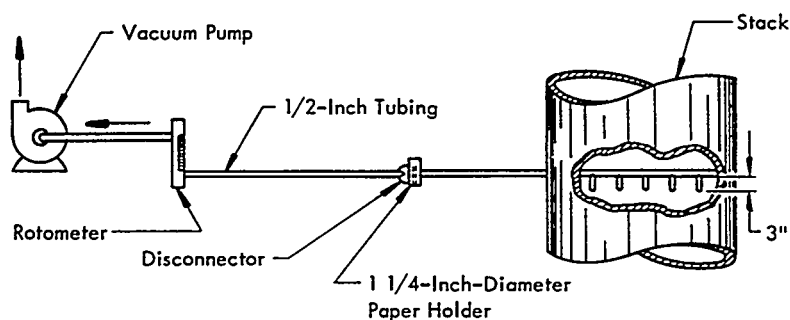
The third portion of my presentation will be used to describe some of the miscellaneous air-monitoring equipment which is currently in use at the Y-12 Plant.

Stack Sampler

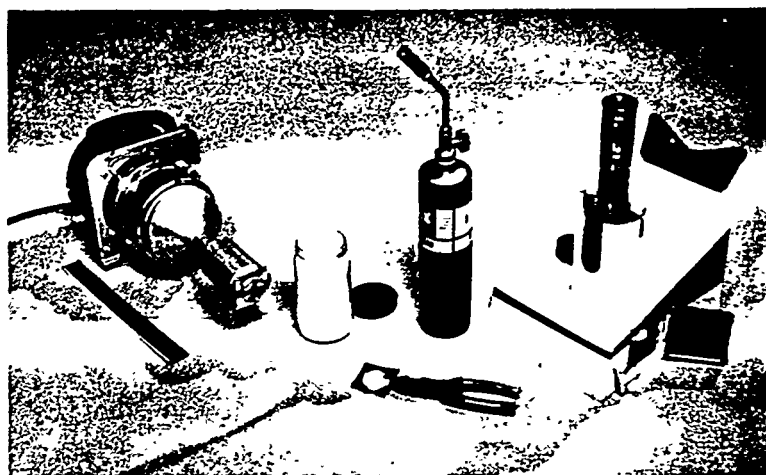
Slide 7 is a typical standardized stack sampler. This device is a rake-type probe sampler which we have adapted for all of our stack-monitoring programs. It is a semi-isokenetic-type sampler. The nozzle holders are adjusted to the velocity of the stack. All probes sample at the rate of one cubic foot per minute. As shown, the disconnect paper holder can be easily removed for impinger sampling of gases or vapors.

Portable Florotometer

Slide 8 shows a device and depicts a technique for sampling where uranium is the contaminant and where normal decay time prior to analysis is not necessary. The



Slide 7. TYPICAL STANDARDIZED STACK SAMPLER.



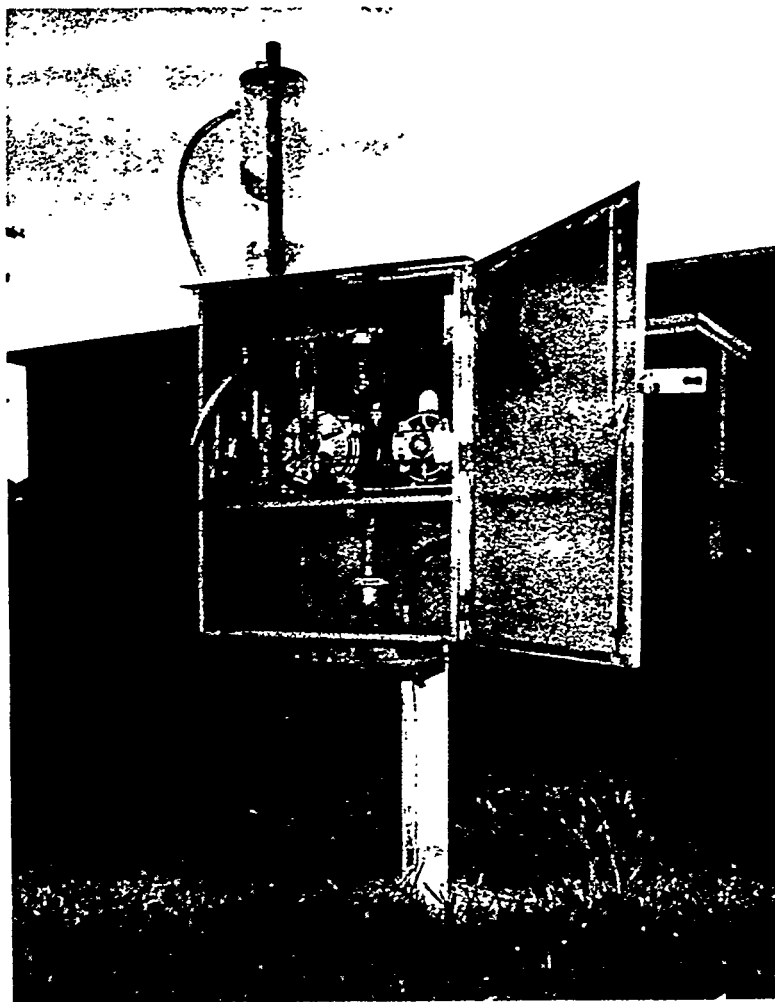
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Slide 8. AIR-SAMPLING APPARATUS AND PORTABLE FLUOROMETER.

technique works as follows: A high-volume air sampler is equipped with an angular impactor. The platinum impacting plate is coated with a thin layer of water-soluble grease. After the sampling period is completed and the particles are impinged on the plate, the plate is removed. A low-temperature flux (potassium fluoride) is placed in the plate. The torch is used to melt the flux, making a fluorescent button. The sample is then placed in a fluorometer which is equipped with a series of standards made on nonhygroscopic lithium fluoride. The flashlight, which you see protruding from the top of the instrument, is an ultraviolet-ray flashlight. When the sample is positioned and the small door on the side of the fluorometer is closed, the fluorescence of the standards can be matched against the sample that was taken. Standards have been prepared from a half part per million up to ten parts per million. When the specific activity of the uranium is known, it is easy to calculate actual air-borne concentrations.

Outside Air Monitor

Slide 9 shows a typical outside air monitor equipped for paper-filter as well as impinger monitoring. This unit uses a Lehman carbon-vein oilless pump requiring essentially no maintenance. Previous systems required considerable maintenance such as oiling several times a week. Since these units are operated 24 hours a day, 365 days a year, maintenance of previous systems became very expensive; however, the only maintenance required on the oilless pump is that the veins (costing sixty-



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Slide 9. TYPICAL OUTSIDE AIR MONITOR.

five cents) must be replaced after 12 to 18 months of continuous operation. Maintenance time required to change the veins in one pump is approximately thirty minutes.

Vehicular Samplers

In Slide 10 we see an example of one of our vehicular samplers which is powered by the intake manifold of the vehicle. This unit will sample one cubic foot of air per minute and can be used with a filter paper and/or impinger.

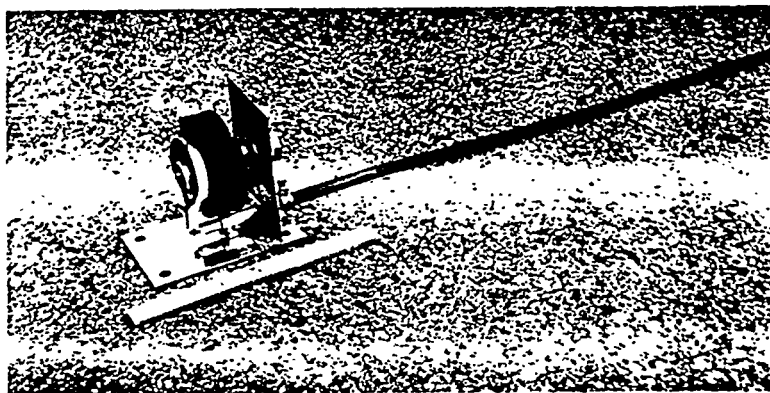


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Slide 10. VEHICULAR SAMPLER.

Compact Sampler

Slide 11 shows a prototype of a compact sampler. Each time an automobile traverses the rubber hose, the piston is activated which, in turn, activates the bellows. The



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Slide 11. BELLOWS AIR MONITOR.

action of the bellows sucks the air on the expanding stroke and a relief valve releases the air from the bellows on the exhaust stroke. This type of unit will be used in remote areas not having regular power outlets.

I have talked generally about the sampling techniques and equipment that we use in our uranium processing areas; however, the techniques, principles, and equipment discussed here are used extensively in sampling many other air pollutants.